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PHYSICS.—*The emissivity of metals and oxides. IV. Iron oxide.*[1] GEORGE K. BURGESS and PAUL D. FOOTE, Bureau of Standards.

This paper is a continuation of the study of the radiometric properties of metals and oxides. By the use of radiation pyrometers and the method of microscopic melts described in the earlier papers, the total and monochromatic emissivity ($\lambda = 0.65\ \mu$) of iron oxide formed by heating iron in air has been determined at high temperatures.

Iron oxide in the spectral region $\lambda = 0.65\ \mu$ is almost "black," having an emissivity varying from 0.98 to 0.92 in the range 800° to 1200°C. The corrections necessary to apply to the readings of an optical pyrometer in this temperature range vary from 0° to 10°C. The total emissivity of iron oxide increases from 0.85 at 500°C. to 0.89 at 1200°C. The corrections necessary to apply to the readings of a radiation pyrometer in this temperature range vary from 30° to 50°C.

The temperature of the outside of the oxide layer is considerably different from that of the inside in contact with the metal, as a result, in part, of the low thermal conductivity of the oxide and, in part, undoubtedly, of the actual separation of the outside oxide layer from the metal, thus forming an air gap between the two surfaces or between two surfaces of oxide, the outer one thick and the inner one thin. The drop in temperature through

[1] To appear in full in the Bulletin of the Bureau of Standards.

the oxide layer is approximately constant for various sized samples from small iron tubes to 100 pound rails, and increases rapidly with temperature, rising to about 100° at an outside temperature of 1100°C.

PHYSICAL CHEMISTRY.—*A study of the quality of platinum ware.*[1] GEORGE K. BURGESS and P. D. SALE, Bureau of Standards.

There has been devised a simple, thermoelectric method suitable for the determination of the purity of platinum ware.[2] This method of analysis does not mar the article tested and gives data for the classification of platinum in terms of its equivalent iridium (or rhodium) content.

There were examined by this thermoelectric method 164 pieces of platinum ware of which 26 per cent contained less than 0.5 per cent iridium and 67 per cent less than 2 per cent of iridium. Of 84 crucibles 36 per cent contained less than 0.5 per cent iridium and 87 per cent less than 2 per cent iridium.

A method has been developed for determination of the exact loss on heating of platinum crucibles, by means of a suitable electric furnace containing no heated metal parts.

Fourteen crucibles of various makes and grades were examined for loss in weight on heating and after acid treatment following each heating. Their magnetic susceptibilities were also determined. The susceptibility of pure platinum is zero and the range of susceptibility of seven "platinum" crucibles was found to be 1 to 125. The value usually given for the magnetic susceptibility of pure platinum is about 20 in the same units.

A summary of the results on losses in weight of a series of crucibles is shown in figure 1 in which each letter refers to a crucible. As abscissae, are plotted the losses in mg. per 100 cm.^{2} for 6 hours at 1200°C. and as ordinates the EMF developed against pure platinum at 1100°C.; there is also indicated on the

[1] To appear in full as a Scientific Paper of the Bureau of Standards. Read before the American Chemical Society, April 2, 1915.

[2] This Journal, 4: 282. 1914.

scale of ordinates the iridium and rhodium contents of platinum corresponding to these EMF's. It is seen that for practically pure platinum the loss in weight is about 1 mg. per hour per 100 cm² at 1200° (crucibles a, b, c, d, e). For platinum containing 7.5 per cent rhodium (crucibles m and n) the loss is about 0.5 mg. per hour, while 2 per cent iridium in platinum (crucible i) increases this loss to 2.5 mg. As shown, the heating losses may be taken as approximately proportional to the iridium or rhodium content for crucibles that are practically free from iron.

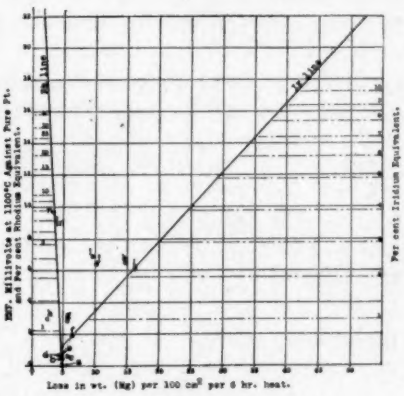

Fig. 1

Iron appears to lessen somewhat the loss of weight on heating (see crucibles g, h, j, k, l, of Fig. 1) but its presence is objectionable on account of the soluble oxide formed on the crucible surface. The chemical analysis and magnetic measurements place the crucibles in only approximately the same order as to iron content; the magnetic susceptibility is not, however, proportional to the iron content.

A microscopic examination of a crucible that has been heated will oftentimes aid in deciding whether it contains rhodium or iridium as the principle impurity, the latter usually showing heavier crystal boundaries and the former imparting a characteristic skew structure.

It appears, therefore, to be possible, from thermoelectric and microscopic examinations of a crucible, to predict its probable loss of weight on heating within limits close enough for analytical purposes.

Whether crucibles have been long in use or not, after the first two or three heatings and acid washings, appears to make little

or no difference on their behavior as to losses on heating and washing.

The nature of the process of disintegration of platinum and its alloys is briefly discussed in the complete paper, and suggestions are there offered concerning the specifications of highest grade platinum crucibles, including the substitution of rhodium to 5 per cent for iridium, and the practical elimination of iron.

GEOLOGY.—*The Paleozoic section of the Ray quadrangle, Arizona.* F. L. RANSOME, Geological Survey.

Introduction. The geologic mapping of the Ray quadrangle, for folio publication as part of the Geologic Atlas of the United States, was completed in 1911. A year or more is likely to elapse, however, before the folio can be published, and as in the meantime there will be occasion in other publications to refer to the Ray geologic section, it appears desirable that a brief preliminary statement regarding this section and its nomenclature should be placed on record.

Pre-Cambrian. The fundamental rocks of the region are the Pinal schist, commonly a thinly laminated sericitic variety, and granitic rocks intrusive into the schist. The Pinal schist consists in the main of metamorphosed sedimentary rocks. Both the schist and the granitic rocks are pre-Cambrian. Whether they should be classed as Algonkian or Archean is a question as yet undecided.

Scanlan conglomerate. Resting as a rule directly on the worn surface of the pre-Cambrian crystalline rocks is the Scanlan conglomerate. The first description of this basal conglomerate appeared in the Globe report[1] where it was assigned a thickness of from 1 to 6 feet and was characterized as being composed of imperfectly rounded pebbles of white quartz, with occasional flakes of schist, in a pink arkosic matrix. The name was derived from Scanlan Pass in the northwestern part of the Globe quadrangle. The conglomerate has since been found to present considerable variation in character and thickness. In parts of

[1] U. S. Geol. Survey, Prof. Paper No. 12, pp. 30-31. 1903.

the Ray quadrangle it is 15 feet thick and contains abundant well-rounded pebbles, some of which are quartzite. In the vicinity of Roosevelt, 35 miles northwest of Ray, the conglomerate rests on granite and is 30 feet thick with well-rounded pebbles up to 9 inches in diameter. The same conglomerate has been recognized in the Santa Catalina Range about 45 miles south-southeast of Ray, where its thickness at one locality was estimated at about 12 feet. The original distribution of this basal conglomerate over an area at least 85 miles from northwest to southeast and at least 40 miles wide is well established. In some places weathered, disintegrated, and recemented granitic detritus, or arkose, lies between the conglomerate and the pre-Cambrian granite.

Pioneer shale. Overlying the Scanlan conglomerate conformably is the Pioneer shale, its type locality being Pioneer Mountain in the northeastern part of the Ray quadrangle, although the name was first applied in the Globe report.[2]

As a rule the Pioneer formation consists of dark reddish brown, more or less arenaceous shale composed largely of fine arkosic detritus with little or no calcareous material. At many places the shale grades downward into arkosic sandstone and in the Apache Mountains, northeast of Globe, 200 feet of this sandstone intervenes between the Scanlan conglomerate and the typical shale. Near Roosevelt the lower part of the formation consists of alternating beds of sandstone and shale. Abundant round or elliptical spots, of light-buff or greenish color, are highly characteristic of the shale. The average thickness of the Pioneer formation in the Ray quadrangle is about 150 feet. It is 200 feet thick, however, in the northeastern part of the quadrangle. In the canyon of Salt River, below the Roosevelt dam, the formation has an estimated thickness of 250 feet.

Barnes conglomerate. The Barnes conglomerate, first described in the Globe report[3] takes its name from Barnes Peak in the northwest part of the Globe quadrangle. In its typical development it consists of smooth pebbles of white quartz and of hard

[2] Op. cit., p. 31.
[3] Op. cit., p. 31.

vitreous quartzite, in an arkosic matrix. The pebbles are generally less than 6 inches in diameter although there are some 8 inches across. Although beautifully rounded, they are not rotund but are flat ellipsoids or round-edged disks. Small fragments or pebbles of bright red jasper, while nowhere abundant, are a very characteristic and constant feature of this conglomerate. The only rocks known that might have furnished these red fragments are certain hematitic jaspers associated with schist in the northern part of the Mazatzal Range, about 70 miles north-northwest of Ray. The matrix of the conglomerate pebbles is arkosic.

In the Ray quadrangle the Barnes conglomerate varies from 10 to 40 feet in thickness. Near Roosevelt it is from 15 to 20 feet thick.

This conglomerate is very constant in character and has a wide distribution. It has been identified in the Sierra Ancha to the north, and in the Santa Catalina Range to the south, the two localities being about 80 miles apart.

The occurrence of a deposit of this character overlying shale is itself indicative of unconformity. Beyond the inference that may be drawn from this relationship however, no evidence of unconformity has been detected.

Dripping Spring quartzite. Conformably overlying the Barnes conglomerate is a formation of quartzite and quartzitic sandstone from 400 to 500 feet thick in the Globe-Ray region. In the Globe report the name Dripping Spring quartzite was applied not only to this formation but also, through error, to a similar stratigraphically higher quartzite whose distinctness from the lower quartzite was not recognized in the intricately faulted area of the Globe quadrangle. The name Dripping Spring quartzite is here redefined as that formation which overlies the Barnes conglomerate and underlies what will presently be described as the Mescal limestone.

In the Ray quadrangle, approximately the lower third of the formation consists of hard fine-grained arkosic quartzite which, as seen in natural sections, shows no very definite division into

distinct beds but does exhibit a pronounced striping, due to the alternation of dull red and dark gray or nearly black bands parallel with the planes of stratification. These as a rule are less than one foot thick. About midway between the top and bottom of the formation the striped beds are overlain by fairly massive beds, up to 6 feet thick, of even-grained buff or pinkish quartzite associated with flaggy, variegated, red, brown and gray beds and with some layers of red and grayish shale that are suggestive of the Pioneer shale. In the upper part of the formation the beds become thin, flaggy, and rusty. The Dripping Spring quartzite, as may be seen from fossil ripple-marks, sun-cracks, and worm-casts, visible on exposed surfaces of the beds, was deposited in shallow water. It contains, however, no pebbles in the Ray quadrangle, and their absence, together with the banding of the lower beds as seen in section, serves to distinguish it from the pebbly cross-bedded Troy quartzite to be described later. The formation is in most localities in the Ray quadrangle closely associated with intrusive masses of diabase, usually in the form of sheets. Some of the characteristics of the quartzite are probably due to the effect of these intrusions.

Mescal limestone. The Mescal limestone conformably overlies the Dripping Spring quartzite and in the Ray quadrangle is well exposed in the Mescal Mountains from which the formation takes its name. It is represented in the Globe quadrangle in a number of small fault blocks and as inclusions in diabase, but when the Globe report was written the limestone of these isolated masses was not known to be distinct from and older than the Devonian and Carboniferous limestones. It was consequently included in the "Globe limestone" of that report.

The Mescal is composed of thin beds that have a varied range of color but are persistently cherty, the siliceous segregations as a rule forming irregular layers parallel with the bedding planes. On weathered surfaces these layers stand out in relief and give to the limestone the rough gnarled banding that is its most characteristic feature. The general hue of the formation is gray or white, but some beds are yellow, some buff and some rusty

brown. Most of the Mescal limestone is magnesian and a part of the formation is dolomite, as may be seen at the Roosevelt dam where the beds are well exposed in the spillway cuts.

Between the limestone and the overlying Troy quartzite is a layer of decomposed vesicular basalt whose maximum observed thickness is from 75 to 100 feet. Although the basalt in places is much thinner than this, the flow was apparently coextensive with the Mescal limestone throughout the Ray and Globe quadrangles, and has been recognized as far north as Roosevelt. This basalt, owing to its small thickness, has been mapped with the Mescal limestone in the Ray quadrangle although it is not included in the definition of that formation. The average thickness of the Mescal limestone is about 225 feet in the Ray quadrangle.

The Mescal limestone has been recognized in the Sierra Ancha and in the Santa Catalina Range. It is in part lithologically identical with and is probably the stratigraphic equivalent of the Abrigo limestone of Bisbee and Tombstone, which contains Middle Cambrian fossils. This correlation, however, is not regarded as sufficiently well established to justify definite application of the name Abrigo in the Ray area.

In all of the regions where it has been identified the Mescal limestone has been extensively invaded by intrusive sheets of diabase and has suffered dismemberment as an effect of the intrusion. In parts of the Ray quadrangle the formation is represented only by detached masses of strata included in diabase.

Troy quartzite. The name of this formation, which lies above the Mescal limestone, is derived from Troy Mountain in the Dripping Spring Range. Everywhere in the Ray quadrangle it is separated from the limestone by the basalt flow and this may possibly indicate some slight unconformity. No evidence of erosion, however, has been detected either below or above the basalt, which may have flowed under water.

The beds of the Troy quartzite range from thin flaggy or shaly layers to cross-bedded pebbly strata from 25 to 50 feet thick. On the whole the thicker beds are characteristic of the lower and middle portions of the formation. The upper part is invari-

ably composed of thin generally yellowish to rusty, worm-marked, shaly quartzite indicative of a change in sedimentation preparatory to the deposition of the succeeding Devonian limestone. The most characteristic material of these upper beds is a fine-grained, unevenly colored, pink and green quartzite in layers an inch or two thick separated by films of olive-gray shale, whose cleavage surfaces are ridged and knotted with numerous worm casts. The most noteworthy features of the thicker beds are their generally pebbly character, which is a useful means of distinguishing isolated exposures of the Troy quartzite from the, locally at least, pebble-free Dripping Spring quartzite, and their conspicuous cross bedding. While the Dripping Spring quartzite is arkosic the Troy quartzite shows little or no feldspar. In the Ray and Globe quadrangles the name quartzite is generally applicable to this formation, but farther north, near Roosevelt and in the Sierra Ancha, it is essentially a sandstone.

The average thickness of the Troy quartzite in the Ray quadrangle is estimated at 400 feet.

General comment on preceding formations. The formations just described, from the Scanlan conglomerate at the base to the Troy quartzite at the top, constitute an apparently conformable series. The name Apache group was applied to these beds in the Globe report, although at that time the Troy quartzite was not distinguished from the Dripping Spring quartzite and consequently did not figure as an individual unit in the group. Moreover, the Mescal limestone, supposed then to be above all of the quartzite, was grouped with the Devonian and Carboniferous limestones of the "Globe limestone." As revised the Apache group now includes, from the base up, the Scanlan conglomerate, the Pioneer shale, the Barnes conglomerate, the Dripping Spring quartzite, the Mescal limestone, and the Troy quartzite.

No identifiable fossils have been found in the beds of the Apache group, but from the facts that it underlies the Devonian, overlies schists and granitic rocks, and appears to be equivalent at least in part to the known Cambrian of the Bisbee District and of the Grand Canyon, it is provisionally classed as Cambrian.

If the Mescal limestone is the same as the Abrigo limestone, the Troy quartzite of course may represent Ordovician or Silurian time, but in the absence of fossils or distinct unconformities it appears safer to consider this quartzite as provisionally of Cambrian age. The entire group has been considered Algonkian,[4] partly because of a supposed resemblance to the Algonkian rocks of the Grand Canyon and partly because the quartzites at Roosevelt were erroneously thought to be unconformably overlain by the Carboniferous limestone. A. B. Reagan[5] also appears to have included a part of the group in the Algonkian while calling what is here designated the Troy quartzite, Tonto (Cambrian).

It is possible of course that a part of the group may be pre-Cambrian, but the apparent conformability of the whole group with the overlying Devonian, taken in connection with the great unconformity between the basal Cambrian of the Grand Canyon with the Algonkian (Unkar and Chuar), lends little support to this view. Additional improbability is cast upon it by the discovery in 1914 that a series of quartzites and shales in the northern part of the Mazatzal Range, hitherto undescribed, are unconformably overlain by some of the formations of the Apache group. The results of this reconnaissance will be brought out more fully in another paper. The hard quartzitic pebbles in the Barnes conglomerate evidently came from the erosion of these older quartzites of the Mazatzal Range. As at present defined therefore the Apache group embraces the apparently conformable series of supposedly Cambrian sedimentary rocks of central Arizona. Should some of the beds turn out to be other than Cambrian the group name will have to be correspondingly restricted or may perhaps be abandoned as no longer a convenient designation for a major stratigraphic unit.

Martin limestone. Conformably overlying the Troy quartzite is a series of limestone beds, some of which carry abundant and

[4] Lee, W. T., Underground waters of Salt River Valley, Arizona. U. S. Geol. Survey, Water-Supply Paper No. 136, p. 96, and fig. 11 on page 97. 1905.

[5] Geology of the Fort Apache region, Arizona. Amer. Geologist **32**: 277. 1903.

characteristic Devonian fossils. These link the formation so closely with the Martin limestone of the Bisbee region as to warrant the extension of the name Martin limestone into the Ray-Globe region.

In the Ray quadrangle the formation is comparatively thin-bedded and is divisible into two nearly equal parts, recognizable in natural sections by a difference in color. The prevailing hue of the lower division is light yellowish gray, while the upper division, less uniform in tint, displays alternations of deeper yellow and darker gray. No identifiable fossils have been found in the lower division which consequently can not be regarded as unequivocably Devonian. The top bed of the formation is a yellow calcareous shale, which breaks up on exposure into minute thin flakes and which consequently has no prominent outcrops. The yellow color is characteristic of all natural exposures, although before weathering the shale is gray. Being overlain by thick-bedded cliff-making Carboniferous limestone, the bed of shale is in many places concealed by talus and its thickness has not been exactly determined. It may be from 15 to 20 feet.

The average thickness of the Martin limestone in the Ray quadrangle is 325 feet, which compares closely with the 340 feet found at Bisbee.

Devonian, presumably the Martin limestone, has been found by Prof. C. F. Tolman Jr.,[6] in the Santa Catalina Range. The presence of the Martin limestone has been fully established also in the Roosevelt section by the finding, in 1914, of sufficient fossils to confirm a lithologic and indecisive paleontologic identification made a year earlier. A list of the fossils, as determined by Dr. Edwin Kirk, and a fuller discussion of the extent and correlation of the Devonian will be published later.

Tornado limestone. The Devonian Martin limestone is conformably overlain by thick-bedded light gray limestone that is nearly everywhere a prominent cliff-maker in the Ray-Globe region. The name here used is derived from Tornado Peak, in the Dripping Spring Range. The Tornado limestone as exposed

[6] Unpublished manuscript of Tucson folio.

in the Ray quadrangle has a maximum thickness of at least 1000 feet. As its upper limit is a surface of erosion dating in part from early Mesozoic time, the limestone was probably at one time much thicker than at present. It is of Carboniferous age. The basal division is about 75 feet thick and forms the lower part of the scarp that in this region is so prevalent a feature of the Carboniferous outcrop. Under the action of erosion this division behaves as a single massive bed, but in reality it is made up of alternating dark and light gray layers, a foot or two thick, which in cliff faces give a banded appearance. This member with a few transitional beds at its top is succeeded by a very massive member, fully 100 feet thick, within which, as exposed in cliffs, there is as a rule scarcely more than a suggestion of divisional bedding planes. These two members together constitute the principal cliff-forming part of the Carboniferous limestone. The third division consists of beds generally thinner than those in the other two divisions but not separable from them by any marked lithological distinction. Thin layers of calcareous shale separate some of the beds but these are a very subordinate part of the formation.

The beds of the two lower divisions carry many fragments of crinoid stems and less abundant rugose corals, with long-winged spirifers and *Rhipidomella*. In the upper division appear different species of *Productus* and *Spirifer*, *Derbya crassa*, *Composita subtilita*, and *Fusulina*. According to Dr. George H. Girty two faunas are represented, one Mississippian and the other early Pennsylvanian. Had it proved practicable to map separately the Mississippian and Pennsylvanian portions of the formation the corresponding names Escabroso limestone and Naco limestone, used in the Bisbee quadrangle, might have been applicable in the Ray quadrangle.

By far the greater part of the formation as exposed in the Ray quadrangle belongs to the Mississippian.

MINERALOGY.—*Nephelite crystals from Monte Ferru, Sardinia.* H. S. WASHINGTON and H. E. MERWIN, Geophysical Laboratory.

A trachytic phonolite forms the upper part of a rounded hill immediately south of Monte Enzu, the culminating point of Monte Ferru.[1] This rock is dense, light gray, aphyric, and composed essentially, as shown by the microscope, of tables of soda-orthoclase, with interstitial nephelite, and small amounts of minute diopside crystals. There are numerous small miarolitic cavities, in which are found small (1–2 mm.) well-formed nephelite crystals, the walls being lined with minute tables of orthoclase and crystals of pyroxene and titanite.

More than one hundred crystals were picked out for examination, twenty-five being selected for the crystallographic and optical examination, and the balance for chemical analysis, the former being undertaken by Merwin and the latter by Washington.

The nephelite crystals are stout, almost equant, prisms, from 1 to 2 mm. in diameter and weighing, on the average, 3 mg. each. They are fresh and clear, except for inclusions of minute augite and titanite crystals.

Usually not more than 4 faces giving satisfactory signals were found on a crystal. The prism appeared vertically striated; the base in all cases gave multiple signals, possessed a pearly luster, and showed grooves parallel to the edges in some cases. The unit pyramid $(10\bar{1}1)$, and the pyramids $(10\bar{1}2)$ and $(20\bar{2}1)$ gave good signals. 12 angles $(10\bar{1}0) \wedge (10\bar{1}1)$ from excellent signals varied between 45°39′ and 45°58′, average 45°49′. 13 other angles from less accurate settings varied between 45°30′ and 46°15′, average 45°51′. 7 angles $(10\bar{1}0) \wedge (10\bar{1}2)$ varied between 26°55′ and 27°18′, average 27°10′. Between $(10\bar{1}0)$ and $(20\bar{2}1)$ 4 angles varied between 63°30′ and 64°20′, average 64°10′. The complements of these observed angles and the corresponding calculated crystallographic constants appear below. With them are placed those for nephelite from Monte

[1] For a description of the lavas of this volcano, see H. S. Washington, Am. J. Sci., **39**: 513. 1915.

Somma (Vesuvius), the only other nephelite for which crystallographic constants have been established; and also 4 angles which are fairly consistent with each other measured by Strüver[2] on two crystals from the Alban Hills.

	Monte Ferru		Monte Somma	Alban Hills
	obs.	*calc.*		
c(0001) ∧ p(10$\bar{1}$1) =	44°10′	44°11′	44° 4′–	40° 1′ 43°51′
" ∧ q(10$\bar{1}$2) =	62°51′	62°47′	62°42′–	62°39′
" ∧ s(20$\bar{2}$1) =	25°50′	25°55′	25°50′	25°41′
$\dot{c}$ =	0.841		0.8386[3]	0.834

Differences in $\dot{c}$ are not surprising in view of the differences in composition shown later.

Refractive indices were determined on fragments of several crystals of the nephelite. $\epsilon = 1.529$, $\omega = 1.532$–3. From independent measurements on two crystals $\omega - \epsilon = 0.0026$. Comparison with other nephelites of determined composition is made in Table 1. The refractive indices are considerably lower than have been observed in other nephelites. A systematic investi-

TABLE 1

	ϵ	ω
Monte Ferru	1.529	1.532–3
Artificial Soda Nephelite[4]	1.533	1.537
Artificial Soda-Lime Nephelite[4]	1.539	1.537
Monte Somma[5]	1.5376	1.5421
Magnet Cove, Ark.[6]	1.5420	1.5468

gation of the relation of composition to optical properties is being undertaken. Available results are as yet too few for discussion.

A complete chemical analysis was made on a batch of 60 crystals weighing in all 0.1865 gram. These were dried at 110°

[2] Zeitschr. Kryst. **1**: 240.

[3] Koksharov, quoted by Dana, gives 0.8389; Baumhauer gives 0.8383, Zeitschr. Kryst., **18**: 613.

[4] N. L. Bowen, Am. J. Sci. **33**: 566. 1912.

[5] Average of 4 accordant determinations. See "Rock Minerals," Iddings; and Zeitschr. Kryst., **22**: 333; **53**: 426.

[6] See "Rock Minerals," Iddings.

and dissolved in hydrochloric acid, and the analysis was conducted by the ordinary methods. Magnesia was not determined owing to lack of material. The optical study of the insoluble portion showed that the augite and titanite crystals had not been attacked, so no correction is needed for impurities introduced from this source. The results are as follows, an average of four out of many fairly accordant analyses of Vesuvian nephelite being given for comparison.

	A	B	C	Ba		
SiO_2	40.27	43.34	42.93	0.722	0.722	2.26
Al_2O_3	31.05	33.45	33.84	0.320	0.320	1.00
Fe_2O_3	2.42	2.60	0.40	0.016		
MgO	–	–	0.15			
CaO	0.81	0.87	2.08	0.015		
Na_2O	15.11	16.28	15.39	0.263	0.315	0.99
K_2O	3.22	3.46	5.08	0.037		
H_2O	–	–	0.18			
Insol.	7.51	–	0.12			
	100.39	99.99	100.17			

A. Nephelite. Monte Ferru, Sardinia. H. S. Washington analyst.

B. Same, calculated free from insoluble.

C. Nephelite. Monte Somma. J. Morozewicz, analyst. Bull. Acad. Sci. Crac. **8**: 979–983. 1907.

Ba. Molecular ratios of B.

BOTANY.—*The North American tribes and genera of Amaranthaceae.*[1] PAUL C. STANDLEY, National Museum.

The North American representatives of the family Amaranthaceae have received little attention from American botanists in either early or recent years. This may have resulted from the unattractive aspect of most of the plants composing the group, but more probably from the circumstance that their generic and specific characters are based chiefly upon very minute floral structures. Because of the small size and often complicated structure of their flowers the plants have, indeed, been considered a "difficult" group, when, as a matter of fact, they are remarkably easy of recognition, and of disposition, provided that generic limits are agreed upon. The species, as a rule, are sharply differentiated. Confusion as to generic limits

[1] Published by permission of the Secretary of the Smithsonian Institution.

has resulted largely from an attempt to recognize in certain tribes too large a number of genera, these based upon vegetative or inconstant characters.

The only monograph of the North American Amaranthaceae is that of Uline and Bray, which appeared about 20 years ago in the *Botanical Gazette*.[2] The conclusions reached by these authors need scarcely be modified now except for certain changes of names necessitated by modern systems of nomenclature. The species treated, however, included only a small part of those found in tropical North America. Moquin had in 1849[3] described all the North American Amaranthaceae then known, in his monograph of the whole family, but naturally many additional species have been discovered in the intervening 66 years, about 155 species being known in North America at the present time. Several of the tribes, particularly the Amarantheae, reach their highest development on this continent. The family being chiefly tropical, South America possesses a larger number of species than North America. Many species are to be found also in Africa and Australia, and a few in Europe and Asia.

The following arrangement of tribes and genera is proposed by the writer for use in a monograph of the family now in preparation for the North American Flora:

I. CELOSIEAE. Differentiated from all other tribes of the family by the presence of 2 or more ovules in the ovary, instead of a single ovule. Only one genus, Celosia, occurs in North America, being represented by 6 species.

II. AMARANTHEAE. Five genera are represented in North America: Lagrezia, Chamissoa, Amaranthus, Acnida, and Acanthochiton.

1. Lagrezia has not been reported previously from outside of Africa, nor has it always been referred to the Amarantheae. Moquin placed it in this tribe, but Dr. Schinz in his treatment of the famly in Engler and Prantl's *Natürlichen Pflanzenfamilien* considered it a synonym of Celosia. There is no doubt that Lagrezia is closely related to that genus, but it seems to be quite distinct in having only a single ovule in the ovary. If the Celosieae and Amarantheae are to be maintained

[2] **19**: 267–272. 1894; **20**: 155–161, 337–344, 449–453. 1895; **21**: 348–356 1896.
[3] In DC. Prodr. **13**^{2}: 231–424.

as separate tribes, Lagrezia must be therefore placed in the latter. In Dr. Schinz's key to the tribes there is no means of telling to which of them a plant with a 1-seeded utricle should be referred. In 1895 Dr. J. N. Rose described a new plant from Manzanillo, Mexico, which he called *Celosia ? monosperma*.[4] This should be referred to the genus here discussed, and may be known as **Lagrezia monosperma**. The few other species of the genus are natives of Madagascar and southern Africa.

2. Chamissoa is represented in tropical North America by two species, the widely distributed *Chamissoa altissima*, and *C. maximiliani*, known within our limits only from Costa Rica. *Chamissoa macrocarpa* H. B. K. has been reported frequently from the West Indies and Central America, but the specimens so determined are *C. altissima*.

3. Amaranthus seems to have its center of distribution in the southwestern United States and northern Mexico. A large number of species are found in the somewhat similar region of Argentina, a number that doubtless will be increased when that country is better explored botanically. About 40 species are known from North America. Most of these are common weeds of cultivated land, but several species are known only from the southwestern mesas and foothills.

Several segregates from Amaranthus have been proposed by different authors, notably Mengea, Euxolus, and Scleropus. With our present knowledge of the group it seems impossible to maintain any of these genera, for the characters depended upon to separate them will not hold when all the species of the genus are taken into consideration.

4. Acnida is a wholly North American genus. Five species are found in salt marches along the eastern and southern coasts of the United States, on the southwest coast of Mexico, and in the West Indies. Three others occur in the central and southwestern United States. The genus is very closely related to Amaranthus, differing only in the absence of a perianth in the pistillate flowers. *Acnida tuberculata* is so closely allied to *Amaranthus torreyi* that it is practically impossible to distinguish staminate plants of the two species, whose ranges largely overlap.

5. Acanthochiton consists of a single species, a native of the sandhills of western Texas, New Mexico, Arizona, and northeastern Mexico. It is distinguished from Acnida only by a vegetative character—the large size and peculiar form of the bracts; but it has always been accepted as a valid genus.

[4] Contr. U. S. Nat. Herb. **1**: 352.

III. CENTROSTACHYDEAE. Two genera of this tribe occur in North America, Centrostachys and Cyathula. The group has always been known as the Achyrantheae; but since the name Achyranthes must be applied to a genus of the Gomphreneae, as explained recently by the writer,[5] it is necessary to form a new tribal name, typified by the best known genus of the group.

The Centrostachydeae reach their highest development in Africa, the East Indies, and Australia. Two Old World species of Centrostachys have become established in tropical and subtropical North America. Two species of Cyathula are found in the same region, *C. prostrata*, a native of the Old World, being established in Jamaica and Panama; while *C. achyranthoides*, an American species, occurs in the Greater Antilles, where it may be adventive, and ranges from southern Mexico to Panama, Brazil, and Chile.

IV. BRAYULINEAE. This is a new tribe, here proposed for the genus Brayulinea, better known by the name Guilleminea, which, unfortunately, is a homonym. The genus is related to the Gomphreneae, with which it has usually been placed, but is distinguished by the perigynous androecium. Apparently Dr. Schinz at one time considered this segregation, for in his key to the tribes of the Amaranthaceae in Engler and Prantl's *Natürlichen Pflanzenfamilien*[6] he separates the tribe Guillemineae. When the text for this part of the family appeared, at a later date than the key, we find no mention of such a tribe, the genus Guilleminea being referred to the Gomphreneae.

In general appearance the species of Brayulinea are quite similar to those of Gossypianthus. One species is found in North America.

V. FROELICHIEAE. It seems desirable to place the genus Froelichia in a tribe separate from the Gomphreneae, to which it has always been referred. The group is characterized by the gamophyllous perianth which becomes indurated and variously appendaged in fruit, characters which are not found in any Gomphreneae.

The genus is an American one, seven species occurring in southern North America, with others in South America. Most of the species are closely interrelated and are separated with difficulty. It is still a matter of doubt how specific limits are to be determined with precision in the genus.

VI. GOMPHRENEAE. Half of the North American genera of the family fall into this tribe, which is, however, best represented in north-

[5] Journ. Wash. Acad. Sci. **5**: 72-76. 1915.

[6] **3**[1a]: 97. 1893.

ern South America. Different authors have proposed very different divisions of genera for the group, but the characters used often have been vegetative or else they proved unreliable as additional species have been discovered. Martius, who was perhaps the most careful student of the group, proposed a large number of genera, based chiefly upon Brazilian species, but scarcely any of his genera are recognized today. The treatment here proposed follows closely that suggested by Otto Kuntze,[7] which was later adopted by Dr. Schinz, and very recently by Dr. Stuchlík.[8] It is based almost wholly upon flower structure, and chiefly upon the characters of the gynoecium and androecium. The North American genera are ten in number, as follows.

1. Cladothrix is closely related to both Gossypianthus and Achyranthes and is distinguished principally by the form of the inflorescence, the flowers being glomerate rather than spicate or capitate. Three species occur in the southwestern United States and in northern Mexico.

2. Gossypianthus is wholly North American, four species being known. One is confined to Cuba, a second is common to Hispaniola, the southwestern United States, and northeastern Mexico, while the other two are found in Texas and Oklahoma.

3. Pfaffia consists of a large number of South American species of diverse habit, some of them resembling the better known species of Gomphrena, while others are tall shrubs or vines. In Mexico and Central America there is a single species which closely resembles some of the species of Iresine. Hebanthe of Martius must be considered a synonym of Pfaffia, although not all the plants described under Hebanthe are true Pfaffias. One plant described by Hemsley as a Hebanthe is to be referred to an older species of Iresine. The proper place of two other Mexican species described by Hemsley is still uncertain. Dr. Watson in 1883 applied the name *Hebanthe palmeri*[9] to another Mexican plant which is not a Pfaffia, but should be known as **Iresine palmeri.**

4. Achyranthes has been discussed by the writer very recently[10] and need not be treated further here.

5. Woehleria is one of the so-called "monotypic" genera. It is endemic in Cuba and is apparently very rare. In general appearance

[7] Rev. Gen. Pl. **2**: 534–545. 1891.
[8] Repert. Sp. Nov. Fedde **12**: 350–359. 1913.
[9] Proc. Amer. Acad. **18**: 144.
[10] Journ. Wash. Acad. Sci. **5**: 72–76. 1915.

the plant is similar to some species of Achyranthes, but the androecium consists of only a single stamen, and the stigma is bilobate rather than capitate.

6. Gomphrena is represented in North America by some fifteen species. Thirteen of these are low plants, with usually large, sessile, and globose heads, closely related to the cultivated globe amaranth, *Gomphrena globosa*. The other two are tall plants with narrow, long-pedunculate, cylindric heads, closely simulating certain forms of Achyranthes. A large number of species of Gomphrena have been described from South America, no less than 66 being reported from Brazil 40 years ago.

7. Iresine is one of the most interesting genera of the Amaranthaceae, chiefly because the plants are of an attractive rather than a "weedy" appearance. About 30 species are known within our limits. The segregates Trommsdorffia and Rosea were proposed by Martius, but it seems impracticable to maintain them as distinct genera.

8. Dicraurus is distinguished from all other genera of the Gomphreneae by the alternate leaves; otherwise it is too closely related to Iresine, and, indeed, it seems probable that ultimately it may be united with that genus. Two species are known, *D. leptocladus* and *D. alternifolius*. The first, a plant of western Texas and northeastern Mexico, has all its leaves alternate; but in the second, a native of Lower California, while most of the leaves are alternate, the lower ones frequently are opposite.

9. Lithophila was based by Swartz upon a plant which is common on the seashores of the West Indies. Some authors have referred the genus to Iresine, but it may be maintained because of the strongly compressed perianth and 2 rather than 5 stamens. Besides the type species, three others, of somewhat diverse habit, are known, all inhabitants of the Galapagos Islands: **Lithophila radicata** (*Alternanthera radicata* Hook. f., 1847), **L. rigida** (*Alternanthera rigida* Rob. & Greenm., 1895), and **L. subscaposa** (*Alternanthera subscaposa* Hook. f., 1847).

10. Philoxerus was proposed by Robert Brown in 1840. The plants of this group have usually been referred to Iresine and Lithophila. Philoxerus seems, however, a valid genus, distinguished from Iresine not only by habit but by the compressed perianth, and from Lithophila by the different structure of the androecium and by the stipitate flowers. Many species of the genus have been proposed, but how many of them are valid is an unsettled question. In North America only a single one is known.

ECONOMICS.—*Efficiency as a factor in organic evolution. II.*[12]
ALFRED J. LOTKA.

ERRORS OF VALUATION

There remains to be discussed the effect upon r or errors of the sense of values, or errors of valuation. We must here apply a different method from the one employed in the case of errors of observation, operation, and mentation, since errors of valuation influence r not through the productive efficiencies of the individual in several activities but through the manner in which the individual distributes his efforts among different activities.

We may proceed as follows:

If an individual had a perfect sense of values he would arrange his affairs, distribute his labor, so that r, the rate of increase per head of the race, were a maximum.[13]

$$\left.\begin{array}{rl} \text{Let } x_1, x_2 \ . \ . \ . & \text{be quantities of commodities produced and consumed per head per unit of time} \\ L_1, L_2 \ . \ . \ . & \text{the labor spent on each commodity per head per unit of time} \\ f_1, f_2 \ . \ . \ . & \text{the fatigue produced per head per unit of time by labor } L_1, L_2 \text{ per unit of time.} \end{array}\right\} \quad (16)$$

Then the individual with a perfect sense of values would, for each commodity, make

$$\left(\frac{\partial r}{\partial x_j} \cdot \frac{\partial x_j}{\partial L_j} + \frac{\partial r}{\partial f_j} \cdot \frac{\partial f_j}{\partial L_j}\right) dL_j = 0 \quad (17)$$

for any arbitrary small dL_j.

$\left(\frac{\partial r}{\partial f}\right.$ is in general a minus quantity$\left.\right)$.

[12] Part I of this paper appeared in this Journal, Vol. 5, no. 10, May 19, 1915, pp. 360-368.

[13] Compare this Journal, 1914, loc. cit.

Let us write (17) in the form

$$(vE + v'E')dL = 0 \tag{18}$$[14]

$$vE + v'E' = 0 \tag{19}$$

The problem before us is, Suppose the individual values the commodity not at v per unit, but at $v + \delta\epsilon$, what will be the effect upon r?

We have:

$$\delta r = \frac{\partial r}{\partial \epsilon}\,\delta\epsilon \tag{20}$$

$$= \frac{\partial r}{\partial x} \cdot \frac{\partial x}{\partial \epsilon}\,\delta\epsilon \tag{21}$$

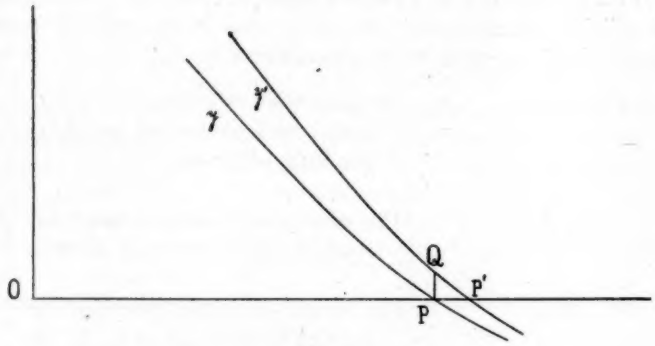

Fig. 1

Consider a graph (see figure 1):

$$y = vE + v'E' \tag{22}$$

$$y' = (v + \delta\epsilon)\,E + v'E' \tag{23}$$

If the individual acted in accordance with the curve y, the *true* curve, he would consume

$$x = OP \tag{24}$$

[14] The quantity $E = \frac{\partial x}{\partial L}$ in equation (18) measures *marginal* efficiency and thus differs from E_j in equation (4), which measures total efficiency.

Instead of this he acts in accordance with the slightly erroneous curve y', and hence consumes

$$x' = OP' \tag{25}$$

so that we may write

$$\delta x = x' - x = OP' - OP = PP' \tag{26}$$

This, because he makes an error in

$$y = vE + v'E' \tag{22}$$

making it

$$y' = (v + \delta\epsilon)\, E + v'E' \tag{23}$$

so that

$$y' - y = E\, \delta\epsilon = PQ \tag{27}$$

$$\delta\epsilon = \frac{PQ}{E} \tag{28}$$

$$\frac{\partial x}{\partial \epsilon} = \frac{PP'}{PQ} E = -E \Big/ \frac{dy}{dx} \tag{29}$$

Substituting in (21) we have:

$$\frac{\partial r}{\partial \epsilon} = -\frac{\partial r}{\partial x} E \Big/ \frac{d}{dx}(vE + v'E') \tag{30}$$

$$= -vE \Big/ \frac{d}{dx}(vE + v'E') \tag{31}$$

which is the desired expression for the differential coefficient $\frac{\partial r}{\partial \epsilon}$ for the case that ϵ denotes an error of valuation.

LIMITATIONS OF THE METHOD HERE DEVELOPED

In conclusion the writer wishes to consider the limitations of the method presented above and to point out their significance and to indicate at what points there is room for further development.

1. We have restricted our attentions to routine or habitual activities, in particular to such as have a definite economic significance.

On reflection it is found that this restriction in practise is almost no restriction at all, that only a vanishingly small pro-

portion of our activities fall outside the scope thus circumscribed. If we actually consider one by one our various activities of a common working day, or for the matter of that of a holiday, we find that, almost without exception, even the most trivial of them are either bought or sold. My breakfast is bought at the butcher's and grocer's. I pay rent for the privilege of sitting at table in my dining room. I pay carfare to be conveyed from my house to my office. Every hour spent at the office is paid for in salary. At night there is again the item of carfare, food, rent, amusements, etc. It is difficult or impossible to find an action ever so trivial which has not a definite money value.

2. A seemingly more serious limitation than the one just considered might seem to lie in the fact that much of the argument presented has been sketched out on a background of examples taken from the special case of the human species. A well developed economic system among living organisms is peculiar to civilized man. It might therefore appear at first sight as if arguments and conclusions involving economic concepts could in no sense be applied to such organisms as those higher animals which in their general habits and characteristics do more or less resemble man.

It must be admitted that in practise this restriction has a real significance. But the difference between the actions of man and those of some of the highly developed species of animals is not so much that the one possesses a sense of values and the others do not, as, that in the case of the one—man—we have in market prices a definite and readily accessible standard of measurement of the values attached by him to various commodities, while in the case of the others—the animals—we have no such readily accessible standard of measurement. To argue that because we have at present no ready means of ascertaining the value set by a given animal upon a given material of consumption, therefore no such value exists, would be parallel to the contention that because men were at one time unable to measure the distance from the earth to the moon, therefore there was no such distance. In the matter of the measurement of values we have not yet reached the epoch where the means for meas-

uring values of materials to animals have been devised. But there is nothing inherently impossible about the solution of the problem of measuring these values, and, in fact, if it seemed worth while, suggestions could be made at this juncture as to how the first crude steps at any rate in this direction might be taken.

Furthermore, since an objective standard of value has been furnished in a previous communication, a standard which is quite independent of the subjective estimate of values and which applies with absolute impartiality to any species, there is in principle no difficulty whatever involved in extending our argument from man to other members of the animal kingdom. The difficulties which arise are only those of translating our results into concrete practical examples.

3. Several restrictions in the scope within which our arguments are strictly applicable are introduced through the fact that we have made use of Jevons' equation for the distribution of labor in different pursuits, or its equivalent. The first of the limitations thus introduced is that our arguments strictly apply only to a community in which there is absolutely free competition and no kind of a monopoly.

In the case of animals this condition is probably in most cases approximately fulfilled.

In the case of a highly developed industrial community of the human species this assumption is very far from the truth. The case of such a community requires special consideration by more complicated methods, and further work in this direction will have to be done to complete the discussion. The writer hopes that perhaps he may be able to take up this phase of the problem on another occasion. In the meantime the simple case here considered illustrates the principles at work just as well as a more complicated case.

4. Another limitation introduced by the use of Jevons' equation is the fact that our arguments apply only to a steady state, in which consumption equals production.

As a matter of fact conditions in nature in all probability approach a steady state in most cases. This is almost inevitable, since a persistent excess of production over consumption would

lead to an ultimately unbounded accumulation of stock. It is of course imaginable that there might be periods of excessive production alternating with periods of excessive consumption. But there are good reasons to believe that such fluctuations, in so far as they do occur, do not exceed certain limits, so that as a first approximation, at any rate, conditions may be regarded as steady. The steady state is a permanent state. Other states in general are transient. For this reason a particular interest attaches to the steady state, which fully justifies any *special* attention paid to it. At the same time it presents the simplest problem and should therefore receive *first* attention. A precisely similar state of affairs to that which confronts us here is familiar to every student of thermodynamics in connection with the theory of Change of State.

5. Certain limitations are introduced by an incompleteness of the Jevons' equation. This equation takes account of only two kinds of terms, those relating to pleasure derived from consumption, and those derived from displeasure bound up with production. Many activities are sufficiently covered by two such classes of terms, but there are certain notable exceptions.

For the individual may labor without any definite calculation of reward, for the mere love of the labor, under the impulse of the *instinct of workmanship*, production itself being a source of pleasure. A flippant disciple of modern industrialism might perhaps remark that cases of this kind are so rare that little error is introduced in leaving them out of account. The writer believes that this is a misconception; that the *instinct of workmanship* fulfils a very definite function in the scheme of nature:

The individual can assist in preserving the species by acts aimed at self preservation; certain egoistic instincts take care of that.

Or, he may assist in preserving the species by acts of service to other individuals of his species. Another set of instincts, altruistic instincts, have been evolved to take care of this. They take various shapes and manifest themselves in different phases of the life of the individual. One of them is the *instinct of workmanship*, which is found not only in man, but also in other species possessing a definite social system, such as the bee.

There would probably be no difficulty in overcoming this limitation of the Jevons' equation by introducing additional terms into it. We shall not carry this out on the present occasion.

6. Lastly, Jevons' equation is built up on a plan which seems to involve the assumption that the individual is a perfectly rational being, weighing all his actions and selecting some definite course after having considered all avenues open to him and the consequences to which they lead.

In point of fact this is far from being the truth even for far-seeing man. Not only are there many circumstances beyond our ken which would enter into the determination of the actions of a more perfect being, but even many of the facts plainly known to the individual may fail to be weighed by him in framing his actions, simply because no man can possibly have the entire contents of his mind consciously before him at all times, or even at any time. In other cases the individual may be aware of certain remote consequences of his actions, but the lure of the immediate gratification derived from such actions may so completely outweigh the promptings arising from a consideration of remote consequences as to induce him to follow a course which yields him a net result of pain rather than pleasure, loss rather than gain. Indeed, nature tricks us into actions of this kind to fulfil her own ends, which are to benefit the species, at the cost of the individual if need be.

Without going into details it may be suggested that this limitation also is, in principle, at least, not as serious as at first sight appears.

In so far as it relates to the inability of the individual to fully realize all the factors which might with advantage be taken into account in framing his actions, it can probably be taken care of under the heading of errors of observation, mentation, and operation.

On the other hand those errors which a man commits in giving undue weight to immediate gratification when in conflict with the prospect of more remote benefits these are plainly errors of valuation and as such fall within the scope of the method here developed.

REFERENCES

Under this heading it is proposed to include, by author, title, and citation, references to all scientific papers published in or emanating from Washington. It is requested that authors coöperate with the editors by submitting titles promptly, following the style used below. These references are not intended to replace the more extended abstracts published elsewhere in this JOURNAL.

ZOOLOGY

HANSEN, H. J. *The Crustacea Euphausiacea of the U. S. National Museum.* Proceedings of the U. S. National Museum **48**: 59–114, plates 1–4. January 19, 1915. (Primarily an enumeration of the localities with remarks on distribution for every species represented; with descriptions, and in some cases figures as well, of several forms.—W. S.)

HARRING, H. K. *Report on Rotatoria from Panama, with descriptions of new species.* Proceedings of the U. S. National Museum **47**: 525–564, plates 16–24. December 15, 1914. (Describes nineteen new species; also contains notes on distribution, and hints on preservation.—W. S.)

KOEHLER, R. *A contribution to the study of ophiurans of the U. S. National Museum.* Bulletin 84, U. S. National Museum. Pp. i–vii, 1–173, 18 plates. April 9, 1914. (Deals chiefly with littoral and deep-sea forms from the Caribbean Sea; twenty-four new species are described; an extended and well illustrated treatment of the genera Amphiura and Ophiacantha is included; also, "to complete the published records of West Indian ophiurans in the National Museum, a list is appended of specimens identified by the Hon. Theodore Lyman, but never reported on."—W. S.)

OSHIMA, H. *Report on the holothurians collected by the U. S. Fisheries Steamer "Albatross" in the Northwest Pacific, during the summer of 1906.* Proceedings of the U. S. National Museum **48**: 213–291, plates 8–11. February 11, 1915. (Describes forty-six new species, and extends the range of eleven others.—W. S.)

PEARSE, A. S. *Habits of fiddler crabs.* Smithsonian Report for 1913, pp. 415–428, 10 text figures. 1914. (With bibliography.)

RATHBUN, MARY J. *A new genus and some new species of crabs of the family Goneplacidae. (Scientific results of the Philippine cruise of the Fisheries Steamer "Albatross," 1907–1910, No. 32.)* Proceedings of the U. S. National Museum **48**: 137–154. December 16, 1914. (A new genus *Homoioplax* is founded on an old species; eighteen new species are described.—W. S.)

RATHBUN, MARY J. *New fresh-water crabs (Pseudothelphusa) from Colombia.* Proceedings of the Biological Society of Washington **28**: 95–100. April 13, 1915. (Describes four new species.—W. S.)

RATHBUN, MARY J. *Stalk-eyed crustaceans collected at the Monte Bello Islands.* Proceedings of the Zoological Society of London, pp. 653–664, plates 1 and 2, September, 1914. (Describes three new species and gives one new name; makes discovery that at least one of the marine crabs, *Naxioides serpulifera,*

undergoes transformation to adult form while still within the brood pouch of the mother.—W. S.)

WILSON, C. B. *North American parasitic copepods belonging to the Lernaeopodidae, with a revision of the entire family.* (Describes twelve new genera and twenty-one new species; gives full notes on ecology and morphology.—W. S.)

ENTOMOLOGY

BARBER, H. S. *The breeding place of* Dermestes elongatus *Leconte.* Proceedings of the Biological Society of Washington **27**: 146. July 10, 1914. (Records the species breeding in the nest of the black-crowned night heron, in the vicinity of Washington, D. C.—J. C. C.)

BÖVING, A. *On the abdominal structure of certain beetle larvae of the campodeiform type: A study of the relation between the structure of the integument and the muscles.* Proceedings of the Entomological Society of Washington **16**: 55-61, pls. 3-6. June 12, 1914. (In this paper the author defines the various areas and sclerites and also gives the muscles causing the boundary lines of the different areas in these larvae.—J. C. C.)

BUSCK, A. *Seven new species of Ethmia from tropical America.* Insecutor Inscitiae Menstruus, **2**: 53-57. April 24, 1914.

BUSCK, A. *New genera and species of Microlepidoptera from Panama.* Proceedings of the U. S. National Museum **47**: 1-67. April 30, 1914. (Describes the new genera Fortinea, Atoponeura, Belthera, Besciva, Galtica, Aroga, Pavolechia, Promenesta, in the Gelechiidae; Hamadera, Costoma, Rhindoma, Ancipita, in the Oecophoridae; and Harmaclona in the Tineidae, together with 123 new species.—J. C. C.)

BUSCK, A. *On the classification of the Microlepidoptera.* Proceedings of the Entomological Society of Washington **16**: 46-54, pl. 2. June 12, 1914.

CAUDELL, A. N. *Some bromeliadicolous Blattidae from Mexico and Central America.* Insecutor Inscitiae Menstruus **2**: 76-80. June 8, 1914. (Describes three new species from Panama and gives notes on other species found in Bromeliaceae. —J. C. C.)

CAUDELL, A. N. *The egg of* Pseudosermyle truncata *Caudell.* Proceedings of the Entomological Society of Washington **16**: 96, *fig. 1.* June 12, 1914. (Illustrates this egg from material collected in Arizona.—J. C. C.)

COOK, F. C., HUTCHINSON, R. H., and SCALES, F. M. *Experiments in the destruction of fly larvae in horse manure.* Bulletin of the U. S. Department of Agriculture, No. 118, Pp. 1-26, pls. 1-4. July 14, 1914. (A professional paper giving details of experiments and suggesting the use of borax as satisfactory in the destruction of the fly larvae.—J. C. C.)

CRAWFORD, D. L. *A monograph of the jumping plant-lice or Psyllidae of the New World.* U. S. National Museum Bulletin 85. Pp. 1-186, pls. 1-30. June 3, 1914. (In this paper the author describes the new genera Aphalaroida, Heteropsylla, Leuronota, Hemitrioza, Uhleria, Tetragonocephala, Katacephala, Mitrapsylla, and the new subgenus Anomoura, together with 62 new species. —J. C. C.)

CRAWFORD, J. C. *Hymenoptera, superfamilies Apoidea and Chalcidoidea, of the Yale-Dominican Expedition of 1913.* Proceedings of the U. S. National Museum **47**: 131-134. April 30, 1914. (Four new species of bees are described.—J. C. C.)

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE GEOLOGICAL SOCIETY OF WASHINGTON

The 293d meeting was held in the lecture room of the Cosmos Club, on March 10, 1915.

INFORMAL COMMUNICATIONS

J. W. SPENCER: *Results of recent soundings at Niagara, and their interpretation.* In October, 1914, the speaker made a re-survey of the crest-line of the Falls and made additional soundings. In the light of these and of previous work an analysis of certain conclusions in the Niagara Folio of the U. S. Geological Survey was given. The folio adopts, in finding the rate of recession, a condition where most of the water temporarily passes over about two-thirds the width of the Falls. This is used as the mean rate for the full breadth. This factor underlies all calculations. The Falls were lately higher than now, as shown by soundings, by borings at the Whirlpool Rapids Narrows, and from the historic records (of Kalm in 1750); and this increased the rate of recession. While the errors made by neglecting these factors are opposing, they do not lead to the correct determination of the age of the Falls. A vertical section under the Falls is given in the folio, showing a depth of water in the gorge of about 200 feet, although the evidence mentioned proves it to be less than 100 feet. Nearly the same amount of work should be performed by the same volume of water, acting on the same set of rocks (height and breadth of the Falls being the same) in the five sections adopted. Yet from the speaker's interpretation, one-quarter the volume (in descending the same height) is made to dig four times as deeply at one point as the full volume at another—a variation in efficiency of 1600 per cent. Between other sections, similar variations appear, while not more than 10 to 25 per cent would be admissible. The age of the Falls as estimated by the speaker is believed to be based on an excessive rate of recession, modified by unsupported opinions to avoid implication of attempts at precision. Thus if we apply calculations alone to his data, the age would be 26,100 years, yet the speaker gives as the sum of his components 19,500 to 30,000 years. The effects of the variable height of the Falls are not considered by him; if these be taken into account the time would be reduced to 14,700 years. The great importance of the age of Niagara lies in its being a chronometer of many geological events, and therefore it should be determined with the greatest precision. The re-survey of the crest-line

made by the speaker reduced the estimated rate of recession from the former figure of 4.2 feet a year to 4 feet. This rate would increase the age of the Falls to 41,000 years.

DAVID WHITE: *The occurrence of transported bowlders in coal beds.* The discovery of stray bowlders in the midst of coal seams is a rare event, but often where one is discovered others are found in the same locality. Several occurrences in the Appalachian field were mentioned, in Tennessee, Pennsylvania, etc. A late discovery in the New River coal field of West Virginia has been reported to the Survey, and a specimen from this find was exhibited. The bowlder was of quartzite, well rounded, and lacquered with coal. The speaker suggested that the character of the rounding seemed to indicate fluviatile action. In explanation of the occurrence of the bowlders it was considered probable that a more or less open lane through the coal swamp had existed, permitting the transportation of bowlders by floating drift.

REGULAR PROGRAM

B. S. BUTLER: *Relation of ore deposits to different types of intrusive bodies in Utah.* The larger intrusive bodies of Utah are of two types, laccoliths and stocks. The laccoliths occur in the sandy and shaly sediments in the southeastern part of the state; the stocks in the quartzites and limestones in the western part of the state. The stocks may be subdivided into those truncated near the apex and those truncated at greater depth. The deeper truncated stocks are uniformly more siliceous. The apically-truncated stocks are monzonitic to diorritic in composition, the deeper truncated stocks have the composition of granodiorite to granite. The ore deposits associated with the laccoliths and deeper truncated stocks have been of comparatively slight commercial importance, while associated with the apically-truncated stocks are deposits of great value. It is believed that the lack of large deposits associated with the laccoliths is due to the fact that after intrusion they were sealed off from their deep-seated source and that the amount of material in the laccoliths themselves was too small and the differentiation on solidifying too incomplete to furnish large deposits. It is believed that in the stocks the differentiation was greater at depth and that the mobile constituents of the magma, as the water and other mineralizers, with silica, metals, sulphur, etc., in solution, rose toward the surface, while the heavier minerals that crystallized early sunk to greater depth. When the mobile constituents reached a point where the magma was sufficiently solidified to fracture they were guided by the fractures or fissures, and on reaching favorable physical and chemical environments began to deposit the metals in solution. The deeper truncated stocks are regarded as probably remnants from which the portion in which the metals were concentrated has been eroded.

Discussion: SIDNEY PAIGE said he was interested in the speaker's views regarding mineralization around laccoliths. In the Black Hills the laccoliths had been fractured vertically, and these fractures

("pipes") had been *loci* of rich mineralization. There was reason to suppose that a large batholith underlay the region, from which, Paige believed, the ore-minerals had been distilled. S. R. CAPPS inquired regarding the field criteria for distinguishing between the several forms of intrusive bodies; laccoliths, apically truncated stocks, and medially truncated stocks. Butler replied that this would be difficult in some cases, but in the region he had described the stocks show distinct cross-cutting characteristics, while the laccoliths had produced evidences of doming in the associated sedimentaries. The boundary between apically and medially truncated stocks is somewhat arbitrary, but often the age of the associated formations gives a basis for judgment as to the depth to which erosion has been carried. For example, if the wall-rocks are of pre-Cambrian strata, erosion is believed to have reached a great depth in the stock. A. C. SPENCER thought Butler's ideas regarding association of minerals with character of stock and depth of truncation very valuable. He believed that analyses of small, undifferentiated sills or laccoliths for ore minerals should give basis of estimation of the original content of the magma in such minerals, before the differentiation which had been effective in larger bodies had resulted in concentration in some parts and impoverishment in others. F. L. RANSOME was inclined to differ with Spencer's opinion on this matter and doubted if such analyses would be of value in drawing conclusions. J. B. UMPLEBY referred to the Idaho districts with which he was familiar. They did not seem to conform with Butler's ideas regarding relation between mineral deposition and depth of truncation. J. T. SINGEWALD, JR., referred to the tin deposits of the Erzgebirge. There was a similar association there to what Butler had described. Tin veins were found around the apices of granitic stocks, while more deeply eroded stocks showed no accompaniment of veins. N. L. BOWEN brought up the question of the probable degree of solidification supposed to have been reached in the stocks at the time of ore-deposition. If the apices had reached a condition of complete solidification there was no apparent reason why they should serve as channels for ore-bearing solutions. Umpleby thought that in such cases solidification had not been complete at time of ore-deposition.

BAILEY WILLIS: *Physiographic provinces of South America.* The speaker described in some detail the broader physiographic features of the continent, such as the delta of the Amazon, the chain of the Andes, the pre-Andean depression, and the plains of Argentina, and explained the processes to which their origin and present condition are due. In many places over broad areas very recent movements of depression or elevation have occurred and may still be continuing.

Discussion: KEITH inquired whether the Argentine plain which had been described was simple or whether it was made up of two or three or several plains which were more or less distinct. Willis replied that in the broad expanse from the pre-Andean depression to the Atlantic there is no evidence of faulting, but warping has produced irregularities of surface. C. H. WEGEMANN inquired as to conditions of sedimenta-

tion in the great, down-warped, synclinal areas in South America in comparison with similar areas of the United States. Willis thought them very similar. In many places the areas are covered with woody or reedy vegetation and in some instances the conditions are apparently favorable for the formation of flat deposits. A. H. BROOKS inquired whether the sketch of the southern Andes made by Willis was intended to imply the presence of a peneplain on top of the Andes. Willis thought that a moderately developed peneplain had existed, although it had not been brought to such a stage but that considerable irregularity had survived. Moreover, a good deal of warping had occurred during elevatory doming. SIDNEY PAIGE referred to Lowthian Green's theory of a tetrahedral earth, and thought that the general unit character of elevation recently undergone by South America tended to support Green's view. A. H. BROOKS inquired as to the origin of fiords along southern coasts. Willis thought they were located in zones of softer rocks which had been cut into by rivers and glaciers. DAVID WHITE inquired whether continental shelves were a marked feature along the southeastern coast where Willis had spoken of recent warping. Willis replied that they were present in some degree of development.

C. N. FENNER, *Secretary.*

THE BIOLOGICAL SOCIETY OF WASHINGTON

The 540th meeting of the Society was held in the Assembly Hall of the Cosmos Club, Saturday, April 17, 1915, with Vice-President ROSE in the chair and 50 persons present.

Under the heading Brief Notes, L. O. HOWARD called attention to the development of mosquito larvae and adults in pools of water formed by melting snow in the mountains of New York state, the eggs having been laid on the ground the previous summer in places where pools would be formed.

The first paper of the regular program was by J. D. HOOD, *Some features in the morphology of the insect order Thysanoptera.* Mr. HOOD gave a general account of the Thysanoptera, called attention to the large amount of systematic work that had been done in it during recent years, and said that it was estimated that about 25,000 forms would be found to exist in the order. He called particular attention to the structure and mechanics of the foot, and to the asymmetrical mouth parts, illustrating the peculiarities of each by diagrams. Mr. HOOD's paper was discussed by Dr. HOWARD.

The second paper was by E. A. GOLDMAN, *Biological explorations in eastern Panama.* Mr. GOLDMAN gave an account of his work in connection with the Smithsonian Biological Survey of the Panama Canal Zone, in 1912, in extreme eastern Panama with a view to determining the faunal relations of that section to the Canal Zone and to western Panama. Very little zoological collecting had previously been done in this region which was scarcely better known than in the 16th Century,

at the time of the Conquest. It proved to be mainly Southern American in faunal characters, with a slight admixture of North and Middle American elements. Many South American species apparently reach their northern limits here. The collections of birds and mammals have been identified, and about 40 of the mammals and 30 of the birds have been described as new. Among the birds are three new genera, two of them of humming birds. No new genera of mammals were taken, but several had not previously been reported from Panama. A new species of *Capybara* was among the more notable mammals. Spiny rats of the genus *Proechimys* were found to be common. The tail, normally long in this animal, is lost through some pathological condition in many individuals, and owing to this circumstance the natives believe in the existence of two species.

GOLDMAN'S paper was illustrated by lantern slide views of the country explored, and of objects pertaining to its natural history. It was discussed by Messrs. WETMORE and LYON.

The third paper was by VERNON BAILEY, *Notes on variation, distribution, and habits of the pocket-gophers of the genus Thomomys*. Mr. BAILEY said these rodents, constituting a genus of the peculiar American family Geomyidae, are distributed over the western United States, extending from Alberta and British Columbia to southern Mexico. They range from the Arctic-Alpine to the Tropical zonal areas and are generally abundant in the regions they inhabit. They are burrowers, live almost entirely underground, and are probably more restricted in their individual habitats than any other of our native mammals. This to some extent accounts for their great range of variation and the large number of recognizable forms, nearly 90. Almost every change in climate, soil, and environment is reflected by some change in the color, size, proportions, or cranial characters. There is wonderful adaptation in their color to that of the soil inhabited by them, varying from creamy white on the light sands of the lower Colorado River flats to dark browns on the volcanic plateaus of Mexico and Arizona, and almost black along the humid Pacific coast region of northwestern California. There is also a pure black form on the coast of Oregon which may be an extreme case of dichromatism, as there are several species with a well marked black phase.

Their habit of burrowing enables the gophers to escape many enemies and to adapt themselves to rigorous climatic conditions. In the past this habit was useful in keeping the soil upturned and "ploughed," but under artificial cultivation by man this habit renders the animals a pest. They are very destructive to root crops, clover, alfalfa, and grain. By cutting roots they often do much damage to orchards, nurseries, and vineyards. They may be destroyed by trapping or on a large scale by placing poisoned food in their burrows. In a revision of the genus just submitted for publication as a number of the North American Fauna a general discussion of the habits is given, as well as descriptions of species and subspecies, and maps showing distribution.

Mr. BAILEY's communication was illustrated by lantern slides from photographs of living animals and of their work. Messrs. COOKE, WILCOX, HOWARD and others took part in the discussion.

The 541st meeting of the Society was held in the Assembly Hall of the Cosmos Club, Saurday, May 1, 1915, with Vice-President ROSE in the chair and 26 persons present.

On recommendation of the council, Admiral G. W. BAIRD was elected to active membership.

Under the heading of Brief Notes and Exhibition of Specimens, Dr. O. P. HAY made remarks on the extinct ground sloths of America and called attention to the existence of a specimen of *Nothrotherium* from North American Pleistocene, in Baylor University, Texas. WM. PALMER announced that he had lately seen an apparently wild specimen of the European skylark in nearby Virginia. He also exhibited the jaws of a ray, *Rhinoptera bonasus*, collected at Chesapeake Beach, Maryland. E. W. NELSON called attention to the newspaper notoriety attained by the San Antonio (Texas) bat roost erected under the misconception that bats were destructive to mosquitoes. He said there was no evidence that the species of bats (*Nyctinomus mexicanus*) in these roosts consumed mosquitoes, and that they foraged so far from these roosts that there would be little likelihood of their consuming insects in the vicinity of San Antonio.

The first communication of the regular program was by C. W. GILMORE, *Observations on new dinosaurian reptiles*. The speaker discussed briefly some of the more important discoveries of dinosaurian fossils made in North America during the past two or three years, referring especially to the explorations conducted by the American Museum of Natural History and Canadian Geological Survey in the Edmonton and Belly River formations in the province of Alberta, Canada. He stated that the recent finding of several specimens, with which were preserved impressions of considerable parts of the epidermal covering, leads us to hope that the time is not far distant when the external appearance of these animals will be as well known as the internal skeleton.

Lantern slides of many of the more striking specimens were shown, the speaker confining himself to brief explanatory remarks regarding their systematic position and their more striking characteristics. The following forms were discussed: *Saurolophus* and *Corthyosaurus* of the trachodont dinosaurs; *Ankylosaurus*, an armored reptile; *Monoclonius*, *Anchiceratops*, *Ceratops*, *Styracosaurus*, and *Brachyceratops*, all of the Ceratopsia or horned dinosaurs. In conclusion, life restorations of *Brachyceratops*, *Thescelosaurus*, and *Stegosaurus*, modelled by the speaker, were exhibited for the first time. (*Author's abstract.*)

Mr. GILMORE's communication was discussed by Messrs. O. P. HAY, NELSON, and LYON.

The second paper was by WILLIAM PALMER, *The basic facts of bird coloration*. The complex and varied coloration of birds was explained as due to several causes which were grouped as pigmental, structural,

chemical, and a mixture of two of these. The basic pigmentation was considered as composed of blackish, reddish, and yellowish cells, the latter being much subdued and principally diluting the others. This coloration group was classed as physiological, in contradistinction to all other tints, colors, and glossiness, which were considered as psychological results due to semi-consciousness, especially to eyesight, food, and certain phases of light.

This arrangement was based on the experience of the speaker on the forest slopes of Mt. Gede, in western Java, where it was found that non-glossy, dark and dingy colored birds were confined almost entirely to a habitat of damp dense ground-cover vegetation, while those clothed in more or less brilliant colors were inhabitants of the intermediate areas above the ground cover and below the dense canopy of the branches of the tall forest growth.

In the tops of the forest trees a different type of coloration was evident; glossy blacks, whites, and grays were exclusively characteristic, or predominant. These types of coloration were continued down into the lowlands in the same order but with different species or genera, and with the tree-top spreading through the more open and drier areas of the lowlands to near and on the ground.

Less definite intermediate areas between the ground cover and the tree tops, less dense, or with a different vegetation, were shown to be habitats of birds largely green or yellow, the result being that the general and special coloration of a bird clearly indicates its habitat, apparent exceptions having been greatly influenced by other factors.

A correlation was made of these distributional results with the birds of eastern North America, which were considered as governed by the same influences, though forest changes in recent times have complicated the question.

The coloration of other animals is governed by the same laws with similar results, so that where white, glossy black, bright and highly colored areas exist on animals, it is due to psychological progressive adaptations, based on a less complex and simpler dull coloration to be considered as basic, primitive, and thus more purely physiological in contrast. (*Author's abstract.*)

Mr. PALMER'S communication was discussed by E. W. NELSON and Hon. GEORGE SHIRAS 3d.

M. W. LYON, JR., *Recording Secretary.*

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